

# Well Number Dependence of Highly Strained GaIn(N)As MQW Structures by Metalorganic Chemical Vapor Deposition

Naoto Jikutani, Shunichi Sato, Takashi Takahashi, Akihiro Itoh, Shiro Satoh  
Research and Development Center, Ricoh Company Ltd.  
5-10 Yokata-Kami, Kumanodo, Takadate, Natori, Miyagi, 981-1241 Japan  
Tel: +81-22-386-2011, Fax: +81-22-386-2405, e-mail: naoto.jikutani@nts.ricoh.co.jp

## Introduction:

Recently, much attention has been paid to GaIn(N)As crystal as a long wave length material on GaAs substrate. In previous papers, our group reported the characteristics of highly strained GaInAs single quantum well (SQW), 1.21 $\mu$ m highly strained GaInAs double quantum well (DQW) stripe laser[1] and 1.3 $\mu$ m highly strained GaInNAs DQW stripe laser[2] grown by metalorganic chemical vapor deposition (MOCVD). And following this, we realized the 1.26 $\mu$ m highly strained GaInNAs triple quantum well (TQW) vertical cavity surface emitting laser (VCSEL) by MOCVD[3] in cooperation with Tokyo Institute of Technology Prof. Iga's group. The well thickness such a highly strained quantum well (QW) exceed Matthews and Blakeslee's critical thickness. However, proper well numbers and their characteristics were not to be clear. So in this paper we will discuss well number dependence of photoluminescence (PL) and stripe laser characteristics on highly strained GaIn(N)As multi quantum wells (MQW) and possibility of applying to 1.3 $\mu$ m GaInNAs lasers.

## Experiment:

First of all, we grew GaInAs/GaAs three types quantum well (SQW, DQW and TQW) and carried out PL measurement before GaInNAs/GaAs MQW structures evaluation. Figure 1 shows the schematic sample structure of GaInAs/GaAs/AlGaAs MQW. MQW structures were grown on GaAs (100) oriented substrate by MOCVD using TMG, TMI and AsH<sub>3</sub>. The highly strained GaInAs MQW layers were grown at low temperature of 540°C. The indium contents of GaInAs QW layers are ranged from about 32% to 42%. The layer thicknesses of GaInAs QW layers and GaAs barrier layers are varied around 7nm and 15nm respectively. The aluminum content of AlGaAs barrier layers is 40%.

## Results and conclusions:

Figure 2, 3 and 4 show PL intensity against PL peak wavelength of each MQW structures. Increasing of well number, the longest observed PL peak wavelength was decreasing due to lattice relaxation. However, the TQW structure shown in figure 4 obtained enough PL intensity around wavelength of 1170nm.

We reported 1.2 $\mu$ m Ga<sub>0.61</sub>In<sub>0.39</sub>As DQW stripe laser

which threshold current density was 200A/cm<sup>2</sup>[4], and 1.294 $\mu$ m GaInNAs DQW stripe laser which threshold current density was 920A/cm<sup>2</sup>[2]. The GaInNAs DQW laser was added nitrogen into a Ga<sub>0.63</sub>In<sub>0.37</sub>As DQW structure which PL peak wavelength was 1160nm. The TQW structure PL peak intensity around wavelength of 1160nm shown in figure 4 was also same degree compare the DQW structure shown in figure 3.

As comparison, figure 5 shows PL spectra of GaInNAs DQW and TQW structures which peak wavelength were about 1280nm. The GaInNAs MQW structures were grown by adding nitrogen into Ga<sub>0.63</sub>In<sub>0.37</sub>As MQW structures at growth temperature of 550°C. This is the same condition and indium content as [2,3]. Their PL intensities are also same degree. So it will be expected highly strained GaInNAs TQW structure is able to apply to 1.3 $\mu$ m band lasers.

Furthermore we will investigate GaIn(N)As MQWs characteristics and well number dependence with a strain amount by X-ray diffraction and stripe laser characteristics. In the conference we will discuss these details.

## References:

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- [3] N. Nishiyama, S. Sato, T. Miyamoto, T. Takahashi, N. Jikutani, M. Arai, A. Matsuutani, F. Koyama, and K. Iga, presented at the 17<sup>th</sup> Int. Semiconductor Laser Conf. 2000, postdeadline paper PD-2
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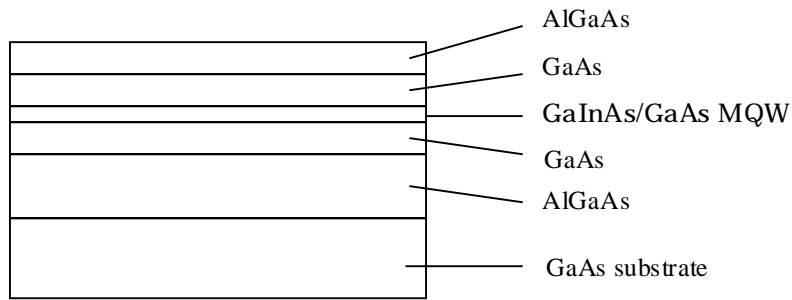


Fig.1 schematic sample structure

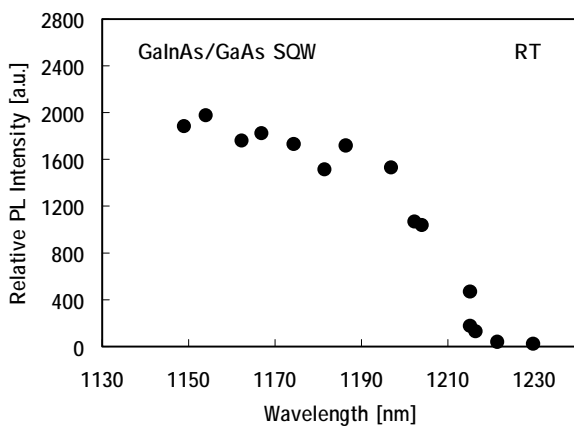


Fig.2 PL intensity of GaInAs SQW structure

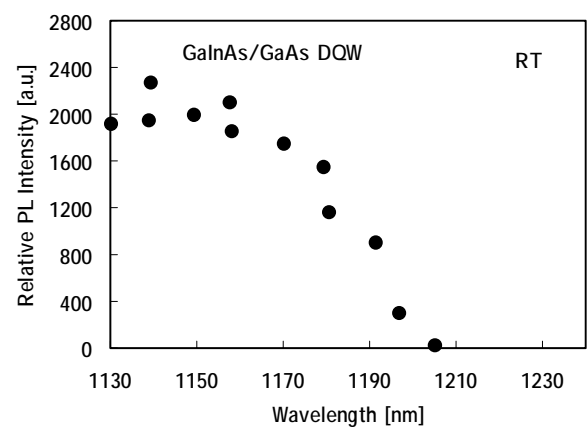


Fig.3 PL intensity of GaInAs DQW structure

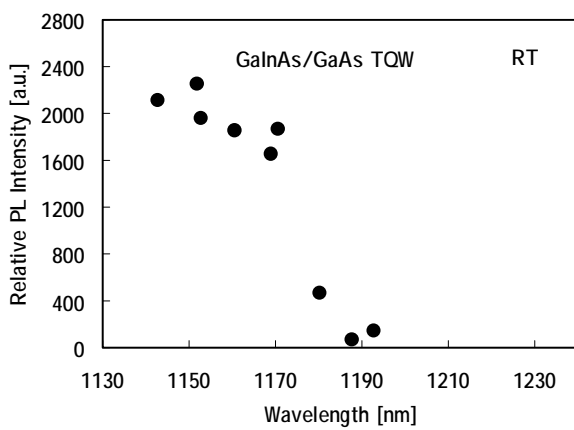


Fig.4 PL intensity of GaInAs TQW structure

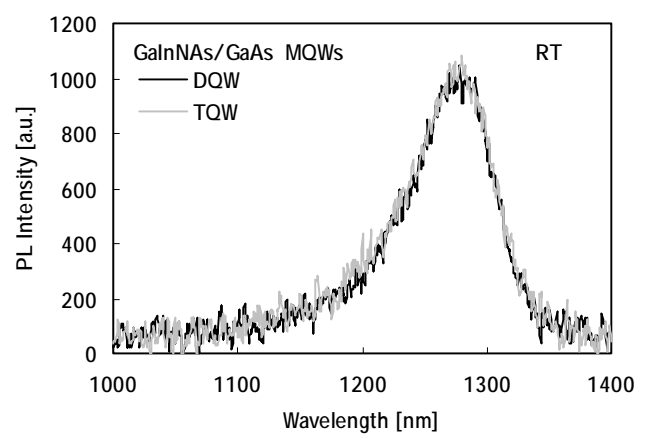


Fig.5 PL intensity of GaInNAs MQW structures